Boulder Creek

Soils Report

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for:
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Introduction

This report discusses the soil resource of the Boulder Creek Project, located on the Bonners Ferry Ranger District of the Idaho Panhandle National Forest. The project area is located in the Bonners Ferry Ranger District of the (IPNF). It lies southwest of Highway 2 about 8 linear miles east of Naples, Idaho. The project area boundary encompasses about 40,612 acres which is the Boulder Creek watershed. This project proposes to treat about 9% of the forest stands (3,433 acres) in the project area using commercial harvest and 18% (7,407 acres) using prescribed fire only. In this analysis, soils are described in regards to their formation, unique properties, strengths and vulnerabilities, and current condition. Activities with known or expected impacts to the soils are identified and receive most of the focus. Expected outcomes from proposed activities and alternatives are discussed along with design criteria that are intended to protect soils.

Overview of Issues Addressed

The analysis of the soil resource addresses existing soil disturbance from past activities within the proposed units and the potential direct, indirect and cumulative effects of proposed treatments within the units.

Soil productivity and function is potentially affected by treatments through erosion, compaction, rutting, displacement and burning. Removal of woody material has the potential to interfere with soil and ecosystem function.

Regulatory Framework

There is an extensive framework in place for the evaluation and determination of the soil condition. For the purpose of the National Environmental Policy Act (NEPA), soils are evaluated in the context of the Idaho Panhandle National Forests Land Management Guides for Soils and the Regional Soil Quality Standards (project file S-38).

The regulatory framework providing direction for protecting soils and a site's inherent capacity to grow vegetation comes from the following principle sources:

- Organic Administration Act of 1897
- Bankhead-Jones Act of 1937
- National Forest Management Act of 1976 (NFMA)
- FSM 2500 – Chapter 2550 – Soil Management
- Land Management Plan (2015 Revision) for the Idaho Panhandle National Forests and Northern Region Soil Quality Standards (project file S-38)

The Organic Administration Act of 1897 (16 U.S.C. 473-475) authorizes the Secretary of Agriculture to establish regulations to govern the occupancy and use of National Forests and "…to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States."

The Bankhead-Jones Act of 1937 authorizes and directs a program of land conservation and land utilization, in order thereby to correct maladjustments in land use, and thus assist in controlling soil erosion, preserving natural resources, mitigating floods, conserving surface and subsurface

moisture, protecting the watersheds of navigable streams, and protecting the public lands, health, safety, and welfare.

The Multiple Use-Sustained Yield Act of 1960 directs the Forest Service to achieve and maintain outputs of various renewable resources in perpetuity without permanent impairment of the land's productivity.

The National Forest Management Act of 1976 (NFMA) charges the Secretary of Agriculture with ensuring research and continuous monitoring of each management system to safeguard the land's productivity. To comply with NFMA, the Chief of the Forest Service has charged each Forest Service Region with developing soil quality requirements for detecting soil disturbance and indicating a loss in long-term productive potential. These requirements are built into forest plans. NFMA specifically states:

> Timber Harvest on National Forest Lands (16 USC 1604(g)(3)(E)): A Responsible Official may authorize site-specific projects and activities to harvest timber on National Forest System lands only where:
>
> a. Soil, slope, or other watershed conditions will not be irreversibly damaged (16 USC 1604(g)(3)(E)(i)).

The Forest Service Manual for soil management (FSM 2500, chapter 2550) establishes the framework for sustaining soil quality and hydrologic function while providing goods and services outlined in forest and grassland land management plans.

The Land Management Plan (2015 Revision) goal, desired conditions, objective and guidelines for soils (Forest Plan p. 23-24) are listed in Table 1. The response to those are included in that table immediately following the reference.

Table 1. Soil References from the IPNF Land Management Plan (2015 Revision) and Region 1 Soil Quality Standards

Land Management Plan Goal	
GOAL-SOIL-01	Maintain soil productivity and ecological processes where functioning properly, and restore where currently degraded. Maintain the physical, chemical, and biological properties of soils to support desired vegetation conditions and soil-hydrologic functions and processes within watersheds.
	Response: All alternatives would make progress towards helping to achieve this goal. The productivity of the soil would be maintained. More detail can be found in the responses to the following plan elements: FW-GDL-SOIL-01, FW-GDL-SOIL-02, FW-GDL-SOIL-03 and FW-GDL-SOIL-04.

Land Management Plan Desired Conditions	
FW-DC-SOIL-01	Soil organic matter, soil physical conditions, and down woody debris maintain soil productivity and hydrologic function. Physical, biological, and chemical properties of soil are within the natural range of variability; enhance nutrient cycling, maintain the role of carbon storage, and support soil microbial and biochemical processes. Areas with sensitive and highly erodible soils or land types with mass failure potential are not detrimentally impacted or destabilized as a result of management activities.
	Response: All alternatives would make progress towards this desired condition. Use of design features and mitigations listed in the EA are expected to protect soil function and productivity.
FW-DC-SOIL-02	Soil impacts are minimized and previous activity areas that have incurred detrimental soil disturbance recover through natural processes and/or restoration activities. Organic matter and woody debris, including large diameter logs, tops, limbs, and fine woody debris, remain on site after vegetation treatments in sufficient quantities to maintain soil quality and to enhance soil development and fertility (refer to FW-GDL-VEG-03).
	Response: All the alternatives would make progress towards this desired condition. There are design features in place that also protect organic matter and help increase coarse woody debris in treatment areas units that are currently low.
FW-DC-SOIL-03	Soil organic matter and down woody debris support healthy mycorrhizal populations, protect soil from erosion due to surface runoff, and retain soil moisture. Volcanic ash-influenced soils that occur on most of the Forest are not compacted and retain unique properties, such as low bulk density and high water holding capacity, to support desired vegetative growth.
	Response: All the alternatives would make progress towards this desired condition. There are design features in place to minimize soil compaction, displacement and other detrimental disturbances while protecting soil organic matter.

Land Management Plan Objective	
FW-OBJ-SOIL-01	Over the life of the Plan, initiate restoration of 75 to 150 acres not meeting soil quality criteria.
	Response: All of the units in this project meet and will continue to meet soil quality criteria after project completion. Therefore, soil restoration is not necessary with this project and will not make any progress toward meeting this objective.
Land Management Plan Guidelines	
FW-GDL-SOIL-01	Ground-based equipment should only operate on slopes less than 40 percent, in order to avoid detrimental soil disturbance. Where slopes within an activity area contain short pitches greater than 40 percent, but less than 150 feet in length, ground-based equipment may be allowed, as designated by the timber sale administrator.
	Response: All alternatives are consistent with this guideline. Alt A would have no ground-based machinery in the units. Alt B & C are consistent because slopes are restricted to 40% in the design features.
FW-GDL-SOIL-02	Coarse woody debris is retained following vegetation management activities per (FW-GDL-VEG-03).
	Response: Alt A would not have vegetation management activities, so the CWD would continue to accumulate at current rates given natural processes. Units that are below recommendations would remain so for the foreseeable future. Alt B & C are consistent with the guideline because the design features would have units meet the recommendations for CWD FW-GDL-VEG-03.
FW-GDL-SOIL-03	In order to provide for leaching of nutrients and maintenance of long-term soil productivity, fine woody debris should be distributed throughout harvest units when conducting vegetation management activities located on nutrient limited rock types and should remain on site for at least 6 months, during one winter (wet/rainy) season, and prior to any subsequent activity such as prescribed burning or mechanical slash piling. Exceptions may occur in areas where a site-specific analysis indicates that leaving fine woody debris untreated would create an unacceptable fire hazard to private property, people, or sensitive natural or historical resources.
	Response: All alternatives are consistent with this guideline. Alt A will continue to have nutrients cycle at current levels through

	natural processes. Alt 2 & 3 are consistent through the implementation of design features.
FW-GDL-SOIL-04	Ground-disturbing management activities on landslide prone areas should be avoided. If activities cannot be avoided, they should be designed to maintain soil and slope stability.
	Response: Alternative 1 is consistent with this guideline. No ground-disturbing activities would take place in Alt 1. In Alt 2 &3, there are approximately 100 acres of helicopter and skyline activities planned on soils with high mass failure potential.
Region 1 Soil Quality Standards	
Region 1 Soil Quality Standard 1	Design new activities that do not create detrimental soil conditions on more than 15 percent of an activity area. In areas where less than 15 percent detrimental soil conditions exist from prior activities, the cumulative detrimental effect of the current activity following project implementation and restoration should not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality.
	No units under any alternative would exceed the thresholds for detrimental disturbance.
Region 1 Soil Quality Standard 2	Organic matter layer thickness would be retained as appropriate for local conditions.
	Implementation of design features would protect the organic matter in all units under both alternatives 2 and 3. Alternative A would also meet this standard due to the lack of any activities.
Region 1 Soil Quality Standard 3	Large woody debris would be maintained at recommended volumes (Graham and others 1994) in each proposed activity area.
	By following the guideline (FW-GDL-VEG-03) in the Land Management Plan, this standard would be met.

The regional soil quality standards (project file S-38) were revised in November 1999. Manual direction recommends maintaining 85 percent of an activity area's soil at an acceptable productivity potential with respect to detrimental impacts, including the effects of compaction, displacement, rutting, severe burning, surface erosion, loss of surface organic matter, and soil mass movement. Regional soil quality standards are found at the end of Table 1.

Affected Environment

Project Area

The project area is located in the Bonners Ferry Ranger District of the (IPNF). It lies southwest of Highway 2 about 8 linear miles east of Naples, Idaho. The project area boundary encompasses 40,612 acres which includes Boulder Creek and all of its tributaries.

Analysis Methods

Analysis Area (Spatial Context)

Regional soil quality standards and guidelines (see table 1) are applied to treatment units. The treatment unit is considered an appropriate geographic unit for assessing direct and indirect soil environmental effects because soil productivity is a site-specific attribute of the land and is not dependent on the productivity of an adjacent area. For example, if 1 acre of land receives soil impacts – resulting in reduced soil porosity, water holding capacity, aeration, long-term productivity – and a second management activity is planned for that same site, then soil cumulative effects are possible. One exception that requires a closer look at the adjacent terrain outside of activity areas would be the evaluation of slope stability to determine if cumulative effects from management activities and roads are detrimental. For these reasons we did not take a watershed approach to determine the evaluation of cumulative effects to soil productivity. Assessing soil quality within too large an area can mask site-specific effects.

The analysis area for direct, indirect, and cumulative effects on soil resources encompasses all land within individual treatment areas. Existing classified National Forest System roads and trails are considered dedicated lands for other purposes and, as such, Region 1 soil quality standards and Land Management Plan guidelines do not apply when evaluating the treatment units. Cumulative effects to soils are those effects that overlap in time and space, so there would be no cumulative effect where there are no direct or indirect effects.

Methods Used

Soil resources in the project area have been reviewed using soil survey data, data in GIS, and field reconnaissance. All soil map units have been field reviewed by the soil scientists to verify mapping, identify areas where soil productivity may be affected by proposed actions, and examine current disturbance on site. In determining a significant change in productivity, a 15% reduction in inherent soil productivity potential will be used as a basis for setting threshold values. This 15% reduction is generally considered a reduction of productivity over 15% of an area. Threshold values would apply to measurable or observable soil properties or conditions that are sensitive to significant change. The threshold values, along with aerial extent limits, would serve as an early warning signal of reduced soil productive capacity, where changes to management practices or rehabilitation measures may be warranted.

Soil resource existing conditions were determined using past harvest records, aerial photography, GIS data, communication with other field personnel, and on-the-ground site visits. Landtypes and potential ratings were gathered from landtype descriptions and characteristics described in the Idaho Panhandle National Forests Land Systems Inventory (project file S-1).

During the summer of 2016 and 2017, proposed timber harvest units were field checked and data was recorded to estimate the degree of soil disturbance. Onsite assessment (Page Dumroese et al. 2009a and 2009b) included shovel tests on random transects to determine soil characteristics, compaction, organic matter depths, and coarse-woody debris content of proposed activity areas.

Transects were also supplemented by visual observations and photos during the walk-through (project file S-2). For data collection the IPNF used the National Soil Disturbance Monitoring Protocol (NSDMP) developed by Rocky Mountain Research Station to describe current soil conditions for harvest areas within the project area. This method uses paced transects with "toe-point" sampling. It uses qualitative indicators of disturbance. At each point, spade holes are used to assess displacement and compaction by looking at soil horizons, soil structure including roots and pores, platyness, and probing to measure soil strength. After porosity and surface woody debris (large woody debris, fine slash, organic matter, and other visual signs of disturbance i.e. ruts, piles of soil, wheel tracks, erosion, burning, displaced topsoil, etc.) are evaluated, each sample point is ranked according to the NSDMP classification system.

In addition to field verification, potential disturbance for the soil resource was estimated using disturbance coefficients created from monitoring data on the Idaho Panhandle National Forests. These methods provide data that is used in the analysis to determine if Forest Plan and Regional Soil Quality Standards would be met.

In each ground based harvest unit monitoring occurred, the following indicators were also examined:

- Percent detrimental[1] soil disturbance: decrease in soil porosity (or increase in soil bulk density) that impairs site productivity, soil displacement, severe soil burning, lack of adequate cover, rutting, or lack of coarse woody debris (CWD)
- Percent cover by category: rock, wood, vegetation, and litter;
- coarse woody debris (logs per acre);
- Litter and duff depths;
- Percent of rock in the uppermost soil horizon; and Slope stability, erosion concerns and other soil issues.

To focus the analysis on those areas that have a higher potential for causing soil disturbance the following table was created.

Table 2. Actions with potential impacts to soils

Planned Actions	Connected Actions	Impact to Soils?	Rationale
Timber Harvest			
Ground-based harvest	Cutting	Yes	Ground-based equipment can cause rutting, compaction and displacement.
	Skidding	Yes	Skidding machinery can compact skid trails, cause rutting and or displacement. Dragging logs can also displace soil and create erosion pathways.
	Landings	Yes	Machinery that compacts, logs are dragged around and potential pile burning can all have negative effects on productivity

[1] Detrimental soil disturbance refers to either decrease in porosity of greater than 10%, or greater than 2 inches of topsoil displaced, eroded, or severely burned, or lack of large woody debris of less than 5 trees per acre with some or all occurring over the harvest area greater than 15% of the area.

Planned Actions	Connected Actions	Impact to Soils?	Rationale
Skyline harvest	Cutting	No	Typically does not contribute to soil disturbance. Logs suspended above ground
	Yarding	Yes	Some soil displacement can occur due to trailing end of logs being yarded
	Landings	Yes	When not on a road, there can be the same compaction, log dragging, and burning issues associated with ground based landings
Fuels Activities			
Grapple piling/mastication		Yes	Contributes to soil disturbance because of ground based machinery effects.
Pile burning		Yes	Potential to alter productivity if improperly executed.
Underburning		Yes	Potential to alter productivity if improperly executed.
Noxious Weed Control			
Spraying roadsides and possibly trails		Yes	Reductions in noxious weeds allows natural vegetation to compete, soil effects are limited

Existing Condition

Soils and Geology

Soils are formed through the interaction of the five soil forming factors. These are climate, organisms, topography, parent material, and time. Geology and geologic processes are important as they provide parent material for soil formation and heavily influence topography, which is a climate modifier. Many soil properties are directly inherited from the geologic characteristics of the parent material. Products of weathering from parent material can significantly influence soil behavior and fertility. That influence can be beneficial or something that requires varying degrees of effort to overcome.

Soils in the Boulder project area are derived from a several geologic formations. The main geologic component of this project is the Pritchard Formation and the Ravalli Group. The Prichard Formation is a Proterozoic to Mesoproterozoic age meta-argillite and quartzite rock package making up the Lower Belt Series. It was deposited in a deep-water facies as a fine-grained clastic wedge. The Ravalli Group is an obsolete term for the Mesoproterozoic belt series rocks comprised of the Burke, Grinnell, Spokane, Revett, St. Regis, and Empire Formations. However in northern Idaho the Burke, Revett, and St. Regis Formations are predominant. This package of rocks contains meta-argillites, siltites and quartzites. It was deposited in an intracratonic basin as a large subaerial clastic wedge. There are also inclusions of different geological processes and Glacial and alluvial deposits as well.

The most productive part of the soil occurs near the surface in the zone of interaction between forest organic material and the mineral soil. In a forest system, this layer of topsoil is frequently only a few inches thick but it contains most of the soil nitrogen, potassium, additional nutrients, and mycorrhizae that must be present for a site to be productive.

In most of the proposed harvest units there is a volcanic ash layer directly beneath this organic layer. This volcanic material accumulated from several Cascade volcano eruptions with most of the ash originating from Mt. Mazama (Crater Lake) in Oregon about 7,000 years ago. Volcanic ash has a high water holding capacity, low bulk density and is associated with high soil productivity. It is the expression of these properties that make it an ideal germination substrate for many native plants and home to an array of important micro and macro organisms. Volcanic ash is vulnerable to erosion by water and wind, especially when disturbed. When moist it is very sensitive to compaction and displacement. When retained on site, it contributes to that site's biological resiliency.

Landscape morphology is primarily composed of dissected, steep mountain side slopes and a minor amount of moderate to low sloping ridges. There are numerous small drainages and narrow riparian zones that feed into the Middle Fork Boulder Creek which in turn all flow into the Kootenai River. Across the landscape, the soil has developed in a pattern consistent with the topographic relief, vegetation, and aspect. The soils have formed from in-situ weathering of existing geologic material; alluvial deposition and removal; and from volcanic ash fall.

The representative soil profile has about 2-3 inches of organic material on the surface. This is followed by 1 to 2 inches of dark, hummus rich topsoil. Textures typically were ashy silt loams or ashy very fine sandy loams. This was followed by a variable five to ten inches of volcanic ash material with a texture of ashy silt loam. The profile generally gives way to subsoil material with little to no pedogenic development or to bedrock.

Soils can experience long-term deficiencies when biologically essential elements, like organic matter, are not sufficiently available. This is especially true when the volcanic ash layer is no longer on site. However, some of the proposed units have had no prior entry and the soils (including the volcanic ash) remain in place. Of the units that have had prior entry, there is very little detrimental soil disturbance. Organic matter levels in the units is highly variable, but the average was 1.1 inches, which is in the optimum range according to Graham and others (1994, project file S-20).

Nutrient cycling is another factor in productivity. As previously mentioned, there is a good amount of natural fertility derived from the geologic material. Harvesting results in the removal of nutrients that have been accumulated in the wood and foliage over time. Yarding limbs and tops can lead to the direct loss of nutrients. Especially in units with low natural fertility, it is important to recycle as many nutrients as possible before removal, which can be done by leaving small-scale debris to leach out nutrients (Baker and others 1989).

Effective management of coarse woody debris and organic matter and follows the research guidelines contained in Graham and others (1994, project file S-20). Coarse woody debris is defined as material derived from tree limbs, boles, and roots greater than 3 inches in diameter and in various stages of decay. It performs many physical, chemical, and biological functions in forest ecosystems and is also a key habitat component for many wildlife species and for stream ecology. Because coarse woody debris is such a valuable part of a functioning ecosystem, a portion of the material must be maintained to ensure that organic matter is recycled for long-term productivity. Nevertheless, in natural systems organic matter fluctuates with forest growth, mortality, fire, and decay.

The average optimum level of fine organic matter is 21 to 30 percent, which equates to 1 to 2 inches of surface litter and humus. Optimum levels of fine organic matter relate to

ectomycorrhizal fungus, which is a good indicator of healthy forest soil. On average there is 1.1 inches of surface litter and humus throughout the project area.

Existing Site Conditions and Past Activities

The existing conditions within the activity units were evaluated in regards to existing detrimental soil disturbance, landtypes and interpretations, wet areas, coarse woody debris, organic matter, and fire.

Low levels of detrimental soil disturbance, coupled with average levels of total organics and coarse woody debris, are indicators of overall health and condition of the soils in the activity areas. While it is desirable to have all units within the recommended levels for all factors, this is rarely the case given the natural variability of forest ecosystems and events such as wildfire.

Until the early 1990s, the soil resource did not receive the same level of consideration that it does today. Design criteria and timber sale contract soil protection items are in place and incorporate current knowledge and understanding of the resource. Soil monitoring is an ongoing activity and a resource used to improve our stewardship of the forest (project file S-37).

Soil Resources

Detrimental Soil Disturbance

Detrimental soil disturbance includes, but is not limited to compaction, rutting and soil displacement. In most units the detrimental soil disturbance is limited to skid trails and landings for ground-based operations. Disturbance from natural events, such as wildlife trails, are not considered detrimental because they are not caused by human activity.

Landtypes and Interpretations

Interpretation ratings for soil behavior have been compiled and are broken into subcategories of mass failure, productivity, surface erosion, subsurface erosion, and landtype sensitivity; each is rated as low, moderate, or high for a particular landtype as displayed in the corresponding tables to the interpreted ratings. Thirty two landtypes have been identified in activity units for alternative 2 and 3. Detailed descriptions and characteristics of each are located in the soils section of the project file (project file S-1).

Mass failure potential is the relative probability of down-slope movement of masses of soil material. Besides natural failure, landslides or slumping can be triggered by a number of mechanisms including harvest activities, severe burning, and related road building. Mass failures detrimentally disturb soils because organic matter, the productive ash layer, and even subsurface layers of the soil can be carried down slope during a failure. The rating for mass failure potential is derived through the use of geographical information systems (GIS). Using GIS, several risk factors can be intersected and a potential rating derived. Within proposed treatment areas for all alternatives, the majority of soils have a low mass failure potential. Based on the Idaho Panhandle National Forests Landtype Survey (project file S-1), there are approximately 100 acres in proposed units that have a high mass failure potential in alternative 2 and 3. See Appendix A and project file S-3 to S-9 for thematic maps displaying the information about the soil resource that is described in the following tables.

Table 3. Mass failure potential for alternatives 2 and 3

Mass Failure Potential	Alternative 2 and 3	
	Acres	Area (%)
Low	3209	96.4
Moderate	20	.6
High	100	3

Rounding may produce small variations in numbers

Slope gradient, soil depth, and water content are all important factors in influencing landslide hazards (Megahan and others 1978). Soil water, a major contributor to higher landslide potential, increases from ridge top to stream bottom, hence the landslide potential varies with slope position. Slides are infrequent at or near ridge tops and become more common with the increase in drainage area. The rest of the units for low and moderate risk of a mass failure are 1 and 94 percent, respectively.

Surface erosion potential is a rating of the relative susceptibility of exposed soils to sheet and rill erosion. Surface erosion potential within proposed treatment areas for both alternatives is rated as low. There are no treatment units in either alternative with a high potential for surface erosion.

Subsurface erosion is a rating of the relative susceptibility of exposed sheet and rill erosion of the subsoils exposed during road construction. Alternative 2 and 3 plans approximately 3.2 miles of new temporary road construction. This amounts to roughly 2.9 acres of land converted to an administrative designation, respectively. Road reconstruction is planned but is generally not an issue in regards to subsurface erosion because there is an existing prism that serves as the site of impact. No detrimental effects are expected from subsurface erosion because all new road construction is occurring on landtypes with a low rating for subsurface erosion potential.

Table 4. Erosion potentials for alternatives 2 and 3

Surface Erosion potential for alternative 2 and 3		
Surface Erosion Potential	Alternative 2 and 3	
	Acres	Area (%)
Low	3209	96.4
Moderate	119	3.6
SubSurface Erosion	Acres	Area (%)

Low	2033	61.1
Moderate	1295	38.9
High	0	0

Rounding may produce small variations in numbers

Landtype Sensitivity is a rating that incorporates mass failure, surface erosion, sediment delivery potentials, and average slope gradient to determine a rating of low, moderate, or high sensitivity for landtypes. This is a multi-factor interpretation that incorporates the potential for soil movement with the landscape feature of slope gradient to rate landtypes sensitivity to movement. Management activities are an important consideration when evaluating the weight an interpretation should be given. In this project area the activity units that contain areas rated with a high sensitivity is 5 percent in alternative 2 and 3.

Within the proposed treatment areas, the majority of soils are rated low and moderate for landtype sensitivity potential in both alternatives. Both alternatives have 89 percent of the units rated as low, which equates to approximately 2963 acres (see Table 5). In general, the soils in both alternatives are low to moderate sensitivity and are expected to do well with the recommended design features.

Table 5 Sensitive landtype

Land Sensitivity Rating	Acres	Area (%)
Low	2963	89
Moderate	264	7.9
High	102	3.1

Soil productivity potential is a rating of the relative capacity or ability of a soil to produce and sustain biomass. Low productivity areas are generally associated with shallow, rocky steep slopes on southerly aspects. Soil productivity is the inherent capacity of a soil to support the growth of specified plants, plant communities, or a sequence of plant communities. In order to estimate detrimental impacts and their effects to site productivity, the distribution, duration, extent, and degree of disturbance is considered.

Soil productivity can be tied to the important duff and litter layer that protects soil, provides nutrients, reduces erosion potential, and maintains soil moisture. Litter prevents the breakdown of soil aggregates and reduces the velocity of any overland flow, thereby reducing the erosion potential (Beschta and others 2004). The productivity potential in alternative 2 and 3 is 79 percent for Moderate and Moderate to High. Within the activity units for alternative 2 and 3 there is

approximately 10 and 11 percent, respectively, of low and low to moderate productivity potential (see Table 6). Design features are in place to deal with issues of productivity, and include measure to protect nutrient cycling.

Table 5. Productivity potential for alternatives 2 and 3

Productivity Potential	Alternative 2 and 3	
	Acres	Area (%)
Low	344	10.3
Low-Moderate	358	10.8
Moderate	2603	78.2
Moderate- High	22	.7

Rounding may produce small variations in numbers

Sediment delivery potential is a rating of the probability of eroded soil reaching a stream channel. By using slope gradient, slope shape, and distance to channel, a rating of low, moderate, or high potential is determined. By using slope gradient, slope shape, and distance to channel, a rating of low, moderate, or high potential is determined.

The landtypes that exhibit moderate to high sediment potential are situated at low- to mid-elevation on mid- to lower side slopes and adjacent to incised drainages. Because drainage courses and riparian zones are buffered and would not be entered or logged, the potential for increased sediment delivery from the moderately to high rated landtype units is minimal.

There is 5 percent of the activity areas in alternatives 2 and 3 that have a high sediment delivery potential to stream channels (see Table 7). As part of project planning, all stream bottoms have an Inland Native Fish Strategy-designated buffer zone that would not be entered by any proposed harvest activities. With established buffer zones, the potential sediment increases from fuel or timber management work is minimal. See the hydrology report for more details.

Table 6. Sediment delivery potential for alternatives 2 and 3

Sediment Delivery Potential	Alternative 2 and 3	
	Acres	Area (%)
Low	2722	81.8
Moderate	483	15.5
High	122	3.7

Rounding may produce small variations in numbers

Wet Areas

When soils have excessive wetness, the potential for damaging compaction, displacement, rutting and erosion are greatly increased when ground-based operations are planned. These types of areas are commonly referred to as seeps or wallows and would be buffered using riparian habitat conservation area guidelines as described in the hydrology report. Refer to soil related design features.

Coarse Woody Debris

The distribution of coarse woody debris is varied throughout the project area. Most of the project area has sufficient levels of coarse woody debris, as recommended by Graham and others (1994)

and FW-GDL-VEG-03. There are 22 units are below the recommended levels as shown in Table 8. They are between 0 and 6 tons per acre. There are six units of these that are not a concern for under recommend amounts. These units (50, 51, 52, 116, 128, and 239) are high use areas for recreation and are being managed for recreation, high accidental fire risk and they are adjacent to WUI. See the fuels report for details.

Table 7. Units with coarse woody debris levels below levels recommended by IPNF Land Management Plan (FW-GDL-VEG-03).

Units	Current Coarse Woody Debris T/ac
43	5
48	4
50	5
51	6
52	1
60	2
62	5
66	3
108	5
112	4
116	6
120	3
128	3
130	5
139	4
140	2
141	3
142	3
172	4
174	2
196	6
239	6

Wildfire and Severely Burned Soils

At the current time, there are no detrimentally disturbed soils from wildfire within the analysis area. Wildfire has occurred in the past in the Boulder planning area. It has historically burned at regular intervals. Since about 1931, fires have been relatively small due to successful fire suppression efforts. See the fire and fuels report for more specific information on the effects of fire on specific units. Wildfire is a natural component in forests and commonly influences soils and watershed processes. However, as a result of fire suppression during the last century, natural fire regimes do not exist anywhere in northern Idaho today (Smith and Fischer 1997).

Weeds

Although some areas within the Boulder project area are currently under weed management direction as prescribed in the Bonners Ferry Ranger District Weed Management Record of Decision (USDA Forest Service 1995) many of the roads are not currently covered under any management direction. However, substantial weed populations occur in the project area, particularly adjacent to roadways. We want to contain or control existing noxious weed populations along road and trail systems, and minimize potential for new weed infestations, to

avoid spread into riparian areas such as Boulder Meadows. See the weeds report for detailed information on weeds within the Boulder project area. Infestations of weeds can have wide-ranging effects. They can impact soil properties such as erosion rate, soil chemistry, organic matter content, and water infiltration. Noxious weed invasions can also alter native plant communities and nutrient cycles, reduce wildlife and livestock forage, modify fire regimes, alter the effects of flood events, and influence other disturbance processes (Olson 1999). As a result, values such as soil productivity, wildlife habitat, watershed stability, and water quality can deteriorate. It is important to manage weeds in the project area carefully to limit the spread into treatment units.

Environmental Consequences

Methodology

This analysis includes potential effects from proposed logging systems, system roads, and temporary roads, landings, and fuels treatments on soils. To determine whether proposed activities would detrimentally impact or have cumulative effects on soils, the results of past monitoring was used. For each alternative, the detrimentally disturbed acres were calculated using coefficients based on past Idaho Panhandle National Forests soil monitoring data (project file S-37).

The coefficients were developed as an average soil disturbance level and equated to harvest equipment; time of year (summer vs. winter logging), fuel treatment methods, and the time of year fuel treatment took place (Table 9). Since the coefficients are based on an average, the areas that have had prior harvest activities could have soil disturbance levels lower or greater than the coefficient's average. This monitoring information is contained in the most recent Idaho Panhandle National Forests Forest Plan Monitoring and Evaluation Report (project file S-37). Calculations incorporated the acres and types of proposed logging, burning, and roads/landings constructed for direct and indirect effects.

Table 8. Potential detrimental disturbance coefficients* used for various logging and prescribed fire scenarios

Proposed Logging Method	Detrimental Disturbance Coefficients (%)
Ground-based harvest with grapple piling and underburning or broadcast burning	13
Skyline Harvest	
With underburning or broadcast burning	3
With grapple piling	7
With mechanical felling	10
Aerial Harvest (helicopter)	0

* From Niehoff 2002

The coefficients are used to predict potential detrimental disturbance for proposed logging and slash treatment scenarios including burning and piling. The level of disturbance increase also depends on the amount or lack of existing skid trails. Activity units that have had little prior disturbance will show a greater incremental increase in potential detrimental disturbance than those units that already contain a network of existing skid trails. Little to no increase in disturbance is expected there because equipment would re-use existing skid trails and move on slash mats whenever possible.

Direct effects on soils from proposed activities were estimated by analyzing the effects of compaction, rutting, erosion, burning, and displacement on the soil surface. This is the most productive layer and also the easiest to disturb through management activities. Compaction, rutting, displacement, and severe burning can affect the soil's physical, chemical, and biological properties, which indirectly can affect the growth and health of trees and other plants. Compaction and rutting reduce soil permeability and infiltration, which can cause soil erosion. Displacement reduces plant growth where topsoil and organic matter are removed. Severely burned soils can become hydrophobic (water repellent) and lead to increased erosion, runoff, and/or reduced productivity. However, this hydrophobic state is typically gone after one season and tends to be discontinuous in nature.

Potential impacts are based on the type of logging system and fuel treatments used. Ground-based and skyline felling systems would be used in alternatives 2 and 3, and the coefficients used for proposed logging systems are displayed in Table 9.

The effects of roads in the treatment areas were evaluated using the forest land management plan and the Northern Region Soil Quality Standard activity areas. Temporary and nonsystem roads within proposed harvest units are considered under the criteria for detrimental disturbance.

Landing sites are assumed to be 0.2 to 0.5 acre in size and receive the most impact from ground-based equipment that processes and transports the logs. Roads and landings that are to remain on the landscape for future use can cause detrimental effects on productivity as those lands become "dedicated" lands.

Generally, detrimental effects on soils are not permanent and depend primarily on soil texture, parent material, aspect, and level of disturbance (i.e. compaction). Vegetative recovery time is approximately ±30 to 70 years as the second growth timber becomes established around the disturbed areas and develops enough crown foliage to intercept and evapotranspire moisture (Dykstra and Curran 2002).

Indirect effects may include the loss of site productivity due to the removal of vegetation and nutrients. Large woody debris is essential for maintenance of sufficient microorganism populations and long-term ecosystem function. Design features (see page 21) are incorporated into the activities to manage large woody debris and organic matter as detailed in the research guidelines contained in Graham and others (1994; project file S-20). These recommendations emphasize retaining specific amounts of coarse woody debris in tons per acre and are defined as any woody residue larger than three inches in diameter.

Cumulative effects include the combination of direct and indirect effects from past, present, and reasonably foreseeable activities. Direct, indirect, and cumulative effects on soils are measured within each activity area, although adjacent land outside of the activity area is considered as well in regards to slope stability.

Spatial and Temporal Context for Effects Analysis

Spatial Context

As previously discussed, regional soil quality standards are applied to treatment units (project file S-38). The treatment unit is considered an appropriate geographic unit for assessing direct and indirect soil environmental effects because soil productivity is a site-specific attribute of the land and is not dependent on the productivity of an adjacent area. One exception that requires a closer look at the adjacent terrain outside of activity areas would be the evaluation of slope stability to

determine if cumulative effects from management activities and roads are detrimental. For these reasons we did not take a watershed approach to determine the evaluation of effects to soil productivity. Assessing soil quality within too large an area can mask site-specific effects.

Analysis Timeframe (Temporal Context)

The temporal scale is dependent on the specific issue being addressed with no one scale being appropriate for all issues. This analysis strives toward an integrated approach to soil processes and function to project future trends in response to proposed management options to the best of abilities based on monitoring of similar projects on the Idaho Panhandle National Forests.

The analysis evaluates the effects of proposed management over all seasons for years or decades. This is complicated by data constraints that require monitoring to detect change – though data are often insufficient to identify even trends or trajectories of change until the impact is large enough or has been occurring for some time. Furthermore, there is often a lag between an action and its observed effect. The temporal scales can be defined as long and short-term. For this evaluation, short-term effects are those that occur approximately within the first 10 years following proposed management activities. Long-term effects are those that are still evident approximately 10 years after proposed management activities.

Alternative 1 – No Action

Direct and Indirect Effects

Timber Harvest and Related Activities – Some of the proposed treatment units have been influenced by past harvest activities and could be affected by present and future land management. There are signs of activity in many units, but none had measureable levels of detrimental disturbance (see Table 11).

Past disturbances within these activity areas are recovering in areas where ground-based yarding occurred or have recovered with little evidence to show harvest had occurred except for the decaying stumps left behind. Past monitoring of skyline yarding operations have found disturbance is localized and tends to recover in a very short period of time (project file S-37).

Because no activities are proposed under this alternative, no new management induced detrimental direct and indirect impacts would occur in the Boulder project area. There would be no additional compaction or displacement beyond the currently existing levels. Those levels will continue to lessen over time. Nutrients would continue to cycle, build up at current rates, and not be subject to removal due to harvest and fuel treatment activities.

Fuel buildup would continue and could contribute to the risk of high-intensity wildfires. The introduction of weeds and unwanted flora following a fire could lead to higher competition between less desirable and native vegetation. Weeds can increase erosion, reduce soil moisture, and deplete nutrient levels (DiTomaso 2000). Because the roots of many noxious weeds are deeper than native grasses, they also contribute less organic matter near the soil surface.

The no-action alternative would not reduce the hazardous fuels within the project area as would the action alternatives. As a result, the no-action alternative would not lessen the existing risk for undesirable wildfire behavior. The risk of crown fires, rapid fire spread rates and large flame lengths would not be reduced as it would with the action alternatives.

The no action alternative would not meet the purpose in need. We want to maintain and improve forest landscape resiliency by providing for tree species, stocking levels, and landscape patterns

that better resist insects, disease, and stand-replacing wildfire(s). A no action alternative would not allow restoration, reduction of fuels, maintenance of habitats or road conditions, and would not provide resiliency to the trees to insect and disease or wildfires.

Cumulative Effects

No additional effects to soils would take place as no harvest and no fuel treatments would be added. With no new activities, no new management induced detrimental cumulative impacts would occur in the project area.

Alternative 2 (Proposed Action) and Alternative 3

Design Features to Protect Soils

To reduce the impacts to soils and soil productivity, alternatives 2 and 3 would use Soil and Water Conservation Practices as described in the Soil and Water Conservation Practices (SWCP) Handbook (project file S-39). This handbook outlines best management practices (BMPs) that protect the soil resources at a higher level than do existing Idaho Forest Practices rules and regulations, thereby incorporating all Idaho State standards.

The following practices are designed to minimize the detrimental impacts of soil compaction, displacement, severe burning, and nutrient and organic matter depletion on long-term soil productivity. The use of these practices would insure that the soil quality requirements listed in the forest plan and Regional Soil Quality Standards would be met.

To retain coarse woody debris and provide nutrient recycling:

- Fine organic matter and large woody debris would be retained on the ground for sustained nutrient recycling in harvest units, consistent with FW-GDL-VEG-03 (LMP revised 2015).
- Downed woody retention levels would be maintained wherever practical. Graham and others (1994) recommendations are for retaining downed woody material greater than three inches in diameter. In any incidental areas with the existing levels are below the recommendations (43, 48, 60, 62, 66, 108, 112, 120, 130, 139, 140, 141, 142, 172, 174, and 196), all breakage of tops and branches would be left on-site and efforts will be made to recruit coarse woody debris that is appropriate for the area.

Table 9. Coarse woody debris recommendations from FW-GDL-VEG-03.

Biophysical Setting	Coarse Woody Debris (T/ac)	Number of Logs per acre	Desired Size
Warm/Dry	5 – 12	6-14	Diameter: >10” with at least 2 pieces >20” Length: >12 inches
Warm/Moist	12 - 33	20-30	Diameter: >12” with at least 10 pieces >20” Length: >12 inches
Subalpine Moister	12-25	20-30	Diameter: >10” (8” for lodgepole pine)
Subalpine Drier	7-15	15-20	Length: >12 feet

- Slash would be left to over-winter nutrients back into the soil for a minimum of one winter. This design feature applies to units 43, 48, 60, 62, 66, 108, 112, 120, 130, 139, 140, 141, 142, 172, 174, and 196, since this units are low on CWD.. Additionally, exceptions may be made when a unit borders private property and the fuel loads are considered an unacceptable risk.
- Prescribed burning and pile burning would occur only when the upper surface inch of mineral soil has a moisture content of 25 percent or more by weight, or when duff moisture exceeds 60 percent, or when other monitoring or modeling indicates that soil productivity will be protected.
- When prescribed fire is utilized, post-burn conditions would result in no more than 25 to 30 percent bare soils (excluding natural conditions) within an activity area (burn unit). On sensitive soils or slopes at or greater than 40 percent, no more than 20 percent of bare soils (excluding natural conditions) would be exposed within the activity area.
- The desired prescribed fire outcome includes retention of organic matter (generally not much less than ¼ of an inch) that protects the soil from rain splash impacts, erosion, a decrease in soil moisture holding capacity, and increased solar surface heating, especially on south-facing slopes.

Estimated Effectiveness: High; research has shown that practices like overwintering material and retaining coarse woody debris are effective means for preserving the nutrient cycle. Likewise, restrictions on burning based on soil moisture and/or duff moisture levels has proven to be highly effective for retaining adequate amounts of organic material for nutrient cycling.

To reduce soil disturbance and compaction during ground-based operations:

- Ground-based yarding would occur on slopes generally under 40 percent. When incidental steeper slopes are encountered, skid trails would not be longer than 150 feet in length along those increased slopes with no turning. Where terrain is conducive, go-back trails would be used to minimize impacts wherever possible.
- All new skid trails would be designated and laid out to take advantage of topography and minimize disruption of natural drainage patterns. Where terrain is conducive, trails would be spaced at least 100 feet or more apart. Mechanized felling and skidding would allow skid patterns to be closer, provided slash mats are used.
- Post-harvest, ground disturbance main skid trails on slopes greater than 30%, and all main skid trails in RHCA units would be covered with randomly placed logs (on the contour) and seeded with the latest seed mix recommended at time of implementation to help increase the micro topography needed to reduce runoff
- All ground based operation activities in harvest units would occur when the soil profile is dry (top 2 to 4 inches) to reduce the effects from compaction (Poff 1996, p. 482). In general, these conditions occur during summer and into fall prior to fire season ending rains. The exception to this is winter harvest operations which are covered below.
- If skid trails are to be decompacted or scarified following ground based harvest and fuel reduction activities, use (C6.633# Temporary Road, Skid Trail/Skid Road and Landing Scarification) in order to reduce compaction and potential for erosion. Decompaction activities should go no deeper than 14 inches and should avoid mixing the soil layers or disrupting their orientation.

The purpose of this activity is to disrupt the compacted layers to help restore soil function. These activities will be conducted when the soil is dry. In general, operations during the dry period typically occur July 1 – October 15, but may vary by year, depending on local weather conditions. The timber sale administrator, in conjunction with the forest soil scientist or a qualified specialist will determine those areas that need to be decompacted.

- Pivoting machinery should be avoided in order to prevent soil displacement (C6.24# Site Specific Special Protection Measures).

Estimated Effectiveness: High: these guidelines meet the Forest and Regional Soil Quality Standard by limiting disturbance to less than 20 and 15 percent, respectively, as shown by post-harvest soil monitoring on the Idaho Panhandle National Forests.

To reduce soil disturbance during skyline operations:

- The leading end of logs would be suspended during skyline yarding.
- Yarding across designated riparian habitat conservation areas will only occur in those units specified by the proposed action alternatives and would ensure the full suspension of logs upon transport.
- Mechanized felling is permitted in skyline/cable units where terrain is conducive. Turning of mechanized felling equipment would be limited to reduce soil displacement.

Estimated Effectiveness: High; past Forest Plan monitoring indicates low amounts of soil compaction and displacement with skyline yarding systems (Forest Plan Monitoring Report, project file S-37).

To reduce soil disturbance and compaction during grapple piling:

- Any ground-based piling of slash (grapple-piling) would be done on slopes 40 percent or less.
- Existing skid trails would be used where possible and would operate on slash mats.
- Burn piles would be small and numerous rather than large and few.

Estimated Effectiveness: Moderate - High; past Forest Plan monitoring indicates less soil compaction and displacement with grapple piling systems when they remain on skid trails or operate on a slash mat (Forest Plan Monitoring Report, project file S-37). Involvement of the sale administrator and experience of operator influence the effectiveness of this.

To reduce soil disturbance and compaction at log landings

- Existing roads would be utilized as landings where appropriate in order to avoid disturbance.
- Landings, as determined by the sale administrator in consultation with the forest soil scientist, other than existing system roads utilized would be decompacted and covered with some residual slash (within guidelines provided by FW-GDL-VEG-03 for coarse-woody debris by habitat type), and seeded upon completion of the sale.

Estimated Effectiveness: High; log landings are high traffic areas where many passes are taking place over the soil surface. When landings are placed on existing system roads the compaction to soils within the unit is greatly minimized.

The estimated effectiveness for decompaction is moderate to high based on information in the 2011 Monitoring Report (project file S-37). Pages 108 and 109 discuss the successes with the

Moyie Place Timber Sale located in the Bonners Ferry Ranger District. Data on ripping to alleviate soil compaction is limited within the forest, but very positive.

To protect soils during winter harvest operations

- For any units harvested in the winter, equipment will operate on ground frozen to a minimum depth of four inches, or on 12 inches of settled snow and a slash mat (C6.4# Conduct of Logging). Snow may be removed, prior to operations, from trails to facilitate freezing into the soil profile. IPNF Forest Plan monitoring shows this to be effective in preventing resource damage.
- No units are required to be harvested during winter. During winter harvest for soil protection, a forwarder will be utilized to help preserve the slash mat in order to be effective (C6.42# Log Forwarding). Use of a slash mat on frozen ground can protect the trail from prematurely beginning to thaw due to sun exposure.
- Suspend operations under wet or thawing conditions. Harvesting during winter conditions requires extra vigilance in monitoring ground conditions in order to recognize the appropriate time to cease operations. Conditions can change rapidly throughout the day, especially in early and late winter. Operations utilizing this design feature are still bound by contract provision B6.6 Erosion Protection and Control.

Estimated Effectiveness: Moderate - High; past forest plan monitoring has shown that operating in the winter within these guidelines is effective at reducing soil compaction by roughly 2 percent when compared to summer operations (Forest Plan Monitoring Report, project file S-37).

Temporary roads:

- All temporary roads would be rehabilitated (all new construction would be recontoured; existing prisms would be placed in a stable condition through recontouring and/or decompaction). Cut/fill slopes and crossings would be reshaped to natural contours. Available slash and large wood material (>3 inches) would be applied to the recontour surface (slash is considered "available" where the equipment can reach it from the working area where the rehabilitation is occurring)

Protections during prescribed fire:

- Prescribed burning and pile burning would occur only when the upper surface inch of mineral soil has a moisture content of 25% by weight, or when duff moisture exceeds 60%, or when other monitoring or modeling indicates that soil productivity will be protected.
- When prescribed fire is utilized, post-burn conditions would result in no more than 25 to 30 percent bare soils (excluding natural conditions) within an activity area (burn unit). On sensitive soils or slopes at or greater than 40%, no more than 20% of bare soils (excluding natural conditions) would be exposed within the activity area.
- The desired prescribed fire outcome includes retention of organic matter (generally not much less than ¼ of an inch) that protects the soil from rain splash impacts, erosion, a decrease in soil moisture holding capacity, and increased solar surface heating, especially on south-facing slopes.

Direct and Indirect Effects of Alternatives 2 and 3

Alternatives 2 and 3 are discussed together to reduce redundancy because the harvest methods and units are the same. Alternative 2 has prescribe burning in the Roadless area while Alternative 3 has no action in the Roadless area. The effects of alternative 3 would be equal to or less than that of alternative 3. The main difference between the alternatives is that the treatment areas in alternative 3 are reduced by approximately 1008 acres from alternative 2. Additionally, alternative 2 contains openings that would be greater than 40 acres in size. For the soil resource in the proposed units, openings greater than 40 acres are considered to be neutral because the harvest activities and methods do not change based upon the opening. The soils are already analyzed for these activities and the opening size will not create units that exceed detrimental soil disturbance threshold limits as defined by Northern Region soil quality standards. Skyline and tractor methods would be used in both alternatives. Table 11 and Table 12 are included for each alternative to show the current condition and expected impacts. The tables for each alternative are separate to facilitate inclusion of all necessary data and provide clarity of each alternative.

Summary

Full productivity potential would be maintained on at least 85 percent of the activity area under the Regional soil quality standards, in every activity area after all activities are complete, the forest plan requirements are consistent with the Regional Standards. Alternative 2 treatments would maintain productivity on 92 percent of the activity area.

Both alternatives B and C would meet Region 1 soil quality standards and the requirements in the Forests Land Management Plan (revised 2015) in 100 percent of the units following all activities as planned. See Table 11 and Table 12 for detailed information by unit.

As specified in the "Design Features to Protect Soil" (see page 18), coarse woody debris would be maintained and/or elevated to recommended levels in all units so that preservation of ecological function is expected. Using Regional guidance for coarse woody debris retention would also comply with the Forests Land Management Plan requirements to maintain sufficient microorganism populations for site productivity. Design features, including nutrient management recommendations, would ensure compliance with the regional standards and Forest plan requirements to maintain sufficient nutrient capital.

Detrimental Soil Disturbance

Timber Harvest - Timber harvest activities that may affect soils include approximately 284 acres for alternative 2 and 3 using a combination of ground-based and skyline harvest methods (Table 11 and Table 12). These vegetation management activities have the potential to cause both direct and indirect effects to soil. Examples of direct effects would be detrimental soil disturbance, such as compaction and displacement. Indirect effects are reductions in productivity.

The level of soil disturbance increase depends primarily on the amount or lack of existing skid trails. Activity units that have had little prior disturbance would show a greater incremental increase in potential detrimental disturbance than those units that contain a network of already existing skid trails (Table 11 and Table 12). Existing skid trails would be used for the proposed harvest whenever possible (see "Design Features to Protect Soil"). Proposed skyline units that were previously yarded with the same logging system have little to no additional impacts because existing corridors would generally be reused.

Soil compaction effects can last for decades but are reversible. For the Boulder project area the soils with existing disturbance show little impact from past harvest. These soils appear to be very resilient. For this reason the existing design features are expected to be sufficient to protect the soils.

Timber harvest activities have the potential to create areas of exposed soil, which allow weeds an opportunity to move into the treatment unit. Proactive treatment of weeds along travel corridors can be effective in minimizing productivity losses due to weed infestations. See the weeds report for detailed information on the weeds in the Boulder project area.

Roads – Permanent system roads are considered dedicated lands and not considered for soil detrimental disturbance under the Northern Region standards or the Forest's Land Management Plan. Proper maintenance of roads is important to limit the amount of sediment that is derived from them. No additional soil impacts would occur from proposed road maintenance activities such as blading, drainage improvements, and surfacing on existing dedicated roads. Approximately three miles of road construction is planned under alternative 2 and 3.

Table 10. Summary of existing conditions, proposed harvest treatments, and potential impacts of proposed activities in alternative 2 and 3 (DSD=detrimental soil disturbance)

Unit	Total Current Detrimental Disturbance (% Area)	Projected Additional Detrimental Distrurbance	Purposed Presription	Logging System	Acres per Unit	Projected Temporary Roads (Acres per Unit)
40	0	13%	**ST**	T	112	0
46	0	13%	**ST**	T	39	0
48	0	10%	**ST**	T	9	0
49	0	13%	**ST**	T	9	0
50	0	13%	**ST**	T	47	0
51	0	13%	**ST**	T	39	0
52	0	13%	**ST**	T	50	0
54	0	13%	**ST**	T	8	0
55	0	13%	**ST**	T	71	0
60	0	10%	**GS**	T	60	0.53
62	0	13%	**SW**	T	38	0.18
66	0	13%	**ST**	T	55	0.13
100	0	13%	**GS**	T	28	0
101	0	13%	**SW**	T	10	0
103	0	13%	**ST**	T	18	0
107	0	13%	**ST**	T	8	0
108	0	13%	**GS**	T	21	0
110	0	12%	**ST**	T	28	0
114	0	13%	**ST**	T	37	0
116	0	13%	**ST**	T	45	0
120	0	13%	**GS**	T	21	0
128	0	12%	**GS**	T	41	0
130	0	13%	**ST**	T	30	0
136	0	13%	**GS**	T	18	0
144	0	13%	**ST**	T	211	0
164	0	10%	**ST**	T	89	0
172	0	12%	**ST**	T	17	0
174	0	10%	**ST**	T	46	0
176	0	10%	**ST**	T	35	0
178	0	13%	**ST**	T	12	0
180	0	13%	**ST**	T	11	0
184	0	13%	**ST**	T	31	0
196	0	13%	**ST**	T	24	0
198	0	13%	**ST**	T	20	0
208	0	13%	**ST**	T	55	0
212	0	13%	**ST**	T	41	0
216	0	13%	**ST**	T	24	0
218	0	13%	**ST**	T	59	0
222	0	13%	**ST**	T	30	0
226	0	13%	**ST**	T	41	0
230	0	13%	**ST**	T	66	0
233	0	11%	**GS**	T	30	0
234	0	13%	**ST**	T	59	0
238	0	13%	**ST**	T	46	0
239	0	13%	**ST**	T	10	0
240	0	13%	**ST**	T	14	0
241	0	13%	**ST**	T	49	0
ST=Seed Tree, GS= Group Selection, SW = Shelterwood; S=Skyline, T= Tractor, H=Helicopter, S/swing= Sky Swing; UB= Underburn, GP = Grapple Pile						

*Cumulative acres and percent of units that are expected given the proposed activities and coefficients for disturbance, as analyzed under the criteria for the Region and forest plan(s)

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Fuel Treatments - Activity-fuel treatments that may affect soils under both alternatives include grapple piling followed by pile burning.

Timber harvesting would open up tree canopies, and logging slash from tree limbs, tops, and unmerchantable pieces would add to existing short-term fuel loadings. Canopy removal would allow wind and sunlight to penetrate, heat, and dry the debris, which could increase potential fire intensity and severity until the slash is treated or naturally abated. However, the long-term risk for a stand-replacing wildfire would be reduced by creating more open stand structures with lower accumulations of smaller diameter fuels that would be less likely to support crown fires. See the fire and fuels report for more information.

Design features would protect the soil resource during activity fuel treatments. Only areas that could be accessed from skid trails or roads would be grapple piled. The residual logging debris and slash that could not be grapple piled and burned could increase potential fire intensity and severity for a few years until snow could compress the debris and the fine organics would decompose. Burning can create direct impacts to soils if too much organic material is removed or fire burns too intensely. Following design features for burning (see the environmental assessment) would help lessen the impact of fire on soils.

Standard and site-specific best management practices to protect soil and water, and practices as described in the Soil and Water Conservation Practices (SWCP) Handbook (FSH 2509.22 USDA 1988) are included as design features and would be applied during timber harvest and road decommissioning, maintenance, and reconstruction to minimize soil erosion. They have been shown to maintain acceptable soil productivity (Seyedbagheri 1996; Idaho DEQ 2001; project file S-37). The SWCP Handbook (USDA Forest Service 1988) outlines best management practices that protect the soil and water resources at a higher level than do existing Idaho Forest Practices rules and regulations, thereby incorporating all Idaho State standards. All best management practices applicable to the Boulder Project can be found in the appendix to the environmental assessment.

Best management practices and post-harvest monitoring is conducted annually by staff of the Idaho Panhandle National Forests to validate the implementation and effectiveness of best management practices and design criteria associated with land management activities (project file S-37). Monitoring results are used to adapt future management actions where improvements in meeting objectives are indicated and show that acceptable productivity potential is maintained.

The best management practices techniques and their effectiveness are documented in several publications (Seyedbagheri 1996; Idaho DEQ 2001). The best management practices would have a high effectiveness in minimizing soil compaction and displacement, address seeding of disturbed areas, limiting operations when soil moistures are high, and addressing conduct of logging. Design features also require piling machinery to use existing trails and stay on slopes less than 40 percent to prevent soil disturbance in excess of guidelines. Design features for grapple piling require operation of equipment over slash mats whenever enough material is available, preferentially reusing existing skid trails if present. Forest plan monitoring and research (Eliasson and Wästerlund 2007) indicates there is reduced soil disturbance if equipment is operated on a slash mat.

Weeds - Ground disturbance could create bare soils and encourage invasive plants to establish new infestations or expand their existing range of occupation. It is expected that weeds will expand even if corridors are treated. As forests grow and the tree canopies close, weeds are largely forced out of those areas due to restricted light. For more information on weeds see the weeds report. The reduction of noxious weeds within the project area boundary would have long-

term positive effects on the soil resource (USDA Forest Service 2001a). Soil stability and productivity would be improved and the expectant return of native vegetation would reduce the erosion potential along roadsides, riparian areas, and openings. A decrease in noxious weeds would likely lead to long-term declines in sediment by promoting native vegetation and restoring surface protection to lessen erosion potential.

Organic Matter, Coarse Woody Debris, and Nutrient Levels

Timber Harvest - Harvesting the tree bole, tops and limbs may cause indirect effects to vegetation as nutrient sources are removed from site. Yarding of tops and limbs is proposed in all units for both alternatives except in units 43, 48, 60, 62, 66, 108, 112, 120, 130, 139, 140, 141, 142, 172, 174, and 196. Yarding tops and limbs is restricted in those units due to the low levels of available coarse woody debris. Logging slash from breakage, which could include tree limbs, tops, and unmerchantable pieces, would remain within all harvest units to overwinter to maintain nutrient levels.

Harvest activities are not expected to reduce soil organic matter within proposed units. Harvest activities may actually increase organics that would contribute to the surface layer through harvest breakage and slash left on-site during the over-wintering period. Following harvest activities and fuel treatments, organic matter recruitment would likely be lessened until vegetation recovers in those areas.

Fuel Treatment - Most of the units have an adequate amount of organic material, and removal of some of it through burning would not be detrimental. Using design features that require burning only when the soil and duff moisture levels are at appropriate benchmarks would help preserve existing coarse woody debris and duff layers.

In most units the current levels of coarse woody debris are within the recommended retention rates. Design features and recommended coarse woody debris levels based on FW-GDL-VEG-03 would provide protection against soil erosion as well as aid in the long-term health of the sites. Use of existing design features would help bring units that have low levels of coarse woody debris into the recommended ranges. Those units already within recommended ranges would be treated accordingly to preserve that. Coarse woody debris recommendations for different sites are displayed in the design features (see Table 10).

No long-term measurable negative effects on organic matter and coarse woody debris are anticipated from post-harvest prescribed fire when soil moisture in the upper surface inch of mineral soil has a moisture content of 25 percent or more by weight or 60 to 100 percent duff moisture. When soils have adequate moisture conditions to retain their biological, chemical, and physical integrity, effects from the loss of forest floor can be minimized (Barnett 1989). The post-harvest prescribed fire is expected to result in a mixed-severity burn. Ensuring proper soil moisture would best protect the soil resource during this activity.

When piling for burning, design features require smaller, more numerous slash piles which would have limited detrimental effects when executed in the late fall/winter or early spring. This is preferable to fewer, larger piles because nutrient losses from heat and volatilization could be considerable. In some cases, burning of slash piles may create localized patches of hydrophobic soils for a short period (as much as 1 to 2 years), but the areas are generally not large or extensive enough to alter slope hydrologic responses or long-term soil productivity (Ice 2003).

On an unpredictable site-specific basis, some drier sites may burn at a severity level that removes all of the protective duff and litter layers, even under managed fire conditions. The duff and litter

layer is important in protecting the soil horizons, both as reducing erosion potential and in maintaining soil moisture. Direct effects of prescribed burning could potentially remove woody debris that would otherwise provide long-term nutrients to the soil as the decay process occurs (Page-Dumroese and others 2006a). In south- and southwest facing units, the prescribed burns would have limited detrimental effects when executed within the recommended soil/duff moisture levels.

Nutrient levels are not expected to decline sufficiently to irreversibly impair soil productivity because material from breakage and slash would be left over-winter on site in harvest units. This would allow for leaching of nutrients from slash into the soil (Garrison and Moore 1998). Fuel treatments such as burning would occur after over-wintering, with an exception made for units that are adjacent to private lands and have a fuels/fire concern.

Soil Movement (Erosion, Mass Failure)

Timber Harvest - Harvest activities are proposed in landtypes rated with low surface erosion potential on 95 percent of the proposed activity areas in alternatives 2 and 3. Subsurface erosion potential is an important interpretation in regards to road building. There are no roads being constructed on soils with high rating for subsurface erosion potential. Approximately 59 percent of the soils are rated low for alternative 2 and 3. Design features would provide protection for all soils in road construction activity areas during implementation. See Table 4 for the surface erosion potentials for both alternatives.

Removal of forest canopy and cover increases landslide potential (Megahan and others 1978; Gray and Megahan 1981). This is primarily due to root decay, soil disturbance, increased snow accumulation, altered melting rates, and soil water increases from reduced interception and transpiration. Megahan and others (1978; project file S-28) found that landslide occurrence increased only slightly when overstory canopy was reduced from 100 percent to 11 percent, but increased dramatically when canopy closure went below 11 percent. They also found that crown cover from shrubs affected landslide occurrence after 80 percent crown removal and indicated that landslide occurrence is more sensitive to shrub removal than tree crown removal. Most units would be grappled piled and burned. In both cases the shrub component is expected to survive and re-sprout quickly. There are no areas of ground base harvesting proposed that have a high rating for mass failure.

Fuel Treatments - In both alternatives, fuel treatments are proposed on landtypes that are rated 93.5 percent low in alternatives 2 and 3 for mass failure (Table 3). As in all burn units, efforts would be made to burn in a light patchy mosaic.

Cumulative Effects

Cumulative effects include the combination of direct and indirect effects from past, present, and reasonably foreseeable activities added to the direct and indirect effects of the proposed activities. Discussions of past, present and reasonably foreseeable actions relevant to the Boulder Project are included in the environmental assessment. Since direct and indirect effects on soils are measured within the activity areas, the cumulative effects analysis area for the soil resource consists of the cumulative impacts within each of activity the areas. See Table 11 and Table 12 for cumulative effects by unit.

Present and Reasonably Foreseeable Activities

As previously discussed, the soils evaluation differs from most other resource evaluations because it is limited to the unit boundaries in most cases. Many other resources are evaluated on a larger cumulative effects area. Because of this, there are many present and reasonably foreseeable activities that are not considered for the soils cumulative effects analysis because they do not leave a discernable trace within unit boundaries. Some activities are not known to occur within the unit boundaries. An example of these would be mining and cattle grazing which may occur in the project area, but not within treatment units.

Timber Harvest – In the reasonably foreseeable future, no additional timber activities within the Boulder timber sale units are proposed or ongoing. If the IPNF get a lot of drought, bug kill or blowdown by the roads, there is a potential for the North Zone Roadside Salvage sale along certain reaches of the main open roads in the project area. Please refer to the past present and reasonably foreseeable table in the EA. If this were to occur little if any additional disturbance would occur to the soil resource because roads are considered an administrative use.

The cumulative result of alternative 2, when timber harvest, fuels treatments and effects from temporary roads are combined, full productivity will be retained on approximately 3145 acres under both the Regional standards and the Forest's Land Management Plan of National Forest System land in the Boulder project area. This is approximately 92 percent of the proposed activity area. Under alternatives 2 and 3, all proposed units are expected to meet Regional and Forest Land Management Plan requirements after all planned activities are concluded.

System roads, including maintenance, are not expected to contribute to the cumulative effects within the project area. Road maintenance activities would not go beyond the existing road prism, and new system roads are considered an administrative use. Temporary roads are proposed and do contribute to the cumulative effects which are displayed in Table 11 and 12 for alternative 2 and 3.

Public Activities - These include things such as firewood cutting, driving roads, camping, snowmobiling, hunting, hiking, motorized trail use and berry picking. These activities are not expected to contribute meaningful or measurable amounts to soil disturbance. The location of most of the activities listed above cannot be predicted. The very nature of most public activities limit disturbance. This is because the majority of activities are done on foot, with hand tools and in a limited area. Therefore, any contribution from these activities is expected to be light and not meet the criteria for detrimental disturbance. Use of hiking trails and motorized trails occurs on dedicated lands that are not managed for timber production and are not considered detrimental disturbance under the Regional standards.

Effects of Wildfire with All Alternatives

Given the absence of fire over numerous decades and increased fuel loads in most parts of the project area, the chance of a wildfire occurring could be enhanced if an ignition starts in an untreated area during extreme dry weather conditions. The proposed vegetation treatment in the project area would not necessarily prevent wildfires from occurring, but would increase the ability to suppress such a fire should ignition occur in treated areas (Maurer 2007).

The probability of a high-severity fire is not certain to occur within the project area during a given timeframe. The fact, however, is that when a fire breaks out, the chances for high-severity fire effects on soils can be much higher in untreated areas with increased fuel loads compared to

those that have successfully completed treatment, including post-harvest logging slash (Certini 2005; Keane and others 2002).

Vegetation and fuel treatments would reduce the chance that a wildfire could have as severe of an effect on soils in treated areas as it could in untreated areas because there would be a reduction in the tons per acre of fuels on treated sites. Burning would also be completed in the spring or fall (not in the hot, dry season); these times of year are more favorable to protection of the soil resource due to higher moisture contents in the mineral and organic portions of the soil surface.

The continued accumulation of dead and down fuel loads contributes to an increased potential for locally severe fire effects on soil and soil productivity in severely burned areas. Soil hydrophobicity is amplified by increased burn severity and reduces water infiltration (Wells and others 1979). It usually returns to pre-burn conditions in no more than 6 years (DeBano 1981). Dyrness (1976) and other studies have documented a much more rapid recovery of 1 to 3 years (Huffman and others 2001). The persistence of a hydrophobic layer will depend on the strength and extent of hydrophobic chemicals after burning and the many physical and biological factors that can aid in breakdown (DeBano 1981). This variability means that post-fire impacts on watershed conditions are difficult to predict and to quantify.

Depending on fire severity and plant characteristics, many plants will survive and reinitiate growth soon after a fire. However, the ability of surviving plants to reestablish, thrive, and reseed in subsequent years will be greatly affected by the presence of invasive plants and weeds (Goodwin and Sheley 2001). Burned areas can contain high initial nutrient levels, exposed ground surfaces, and low shade with high light conditions which all directly favor colonization of new and remaining invasive plants. Survival coupled with disturbances produced by fire can cause rapid and expanded invasive plant growth. As a result, values such as soil productivity, wildlife habitat, watershed stability, and water quality often deteriorate.

If a wildfire occurred in the Boulder Project Area, consequent resource damage from mechanized suppression activities and burn severity could range from negligible to severe, depending on location, size, severity of burn, and subsequent administrative activities. Risks for erosion and mass failure would primarily be on steep slopes, and associated roads, especially at stream crossings in the event of debris flows. Wildfire is unpredictable in many ways, but the effects of a severe wildfire on the soil resource can be reduced greatly by implementing vegetation management treatments.

Regulatory Consistency

Forest Land Management Plan Guidelines

The proposed activities would comply with the Forest Land Management Plan Guidelines for maintaining soil productivity.

FW-GDL-SOIL-01: Ground-based equipment should only operate on slopes less than 40 percent, in order to avoid detrimental soil disturbance. Where slopes within an activity area contain short pitches greater than 40 percent, but less than 150 feet in length, ground-based equipment may be allowed, as designated by the timber sale administrator.

Alternatives 1, 2, and 3 would comply with forest plan requirements 1 because all proposed activity areas would be at or below soil quality limits for disturbance and would maintain the

acceptable productivity potential for managed vegetation. Alternative 1 would comply with this requirement because no new management-induced detrimental direct and indirect impact would occur. The proposed activities have the potential to disturb approximately 284 acres with alternative 2 and 3. Proposed activities would result in detrimental soil disturbance in approximately 8 percent for alternatives 2 and 3, of the activity areas following activities.

FW-GDL-SOIL-02: Coarse woody debris is retained following vegetation management activities per (FW-GDL-VEG-03).

Alternative 1 would not comply with FW-GDL-SOIL-02. Currently, sixteen of the harvest treatment units lack sufficient coarse woody debris to meet the recommendations (43, 48, 60, 62, 66, 108, 112, 120, 130, 139, 140, 141, 142, 172, 174, and 196) in Table 8. Alternatives 2 and 3 would comply with FW-GDL-SOIL-02 because limbs and tops would remain in the units that are currently low. Large woody debris retention would follow the guideline of FW-GDL-VEG-03 to ensure the maintenance of site productivity. Methods would include a reduction in grapple piling and/or leaving logging residue of breakage and limbs.

FW-GDL-SOIL-03: In order to provide for leaching of nutrients and maintenance of long-term soil productivity, fine woody debris should be distributed throughout harvest units when conducting vegetation management activities located on nutrient limited rock types and should remain on site for at least 6 months, during one winter (wet/rainy) season, and prior to any subsequent activity such as prescribed burning or mechanical slash piling. Exceptions may occur in areas where a site-specific analysis indicates that leaving fine woody debris untreated would create an unacceptable fire hazard to private property, people, or sensitive natural or historical resources.

Alternative 1 would comply with FW-GDL-SOIL-03. Since no harvest activities would occur with alternative 1, there would be no removal of material. Alternative 2 and 3 both meet the guideline because material will be overwintered prior to fuels treatments and no units occur on nutrient limited rock types.

FW-GDL-SOIL-4: Ground-disturbing management activities on landslide prone areas should be avoided. If activities cannot be avoided, they should be designed to maintain soil and slope stability.

In alternative 2 and 3 there are zero acres of high mass failure potential that is being ground based harvested. There is 100 acres that will be helicopter or Skyline harvested.

Region 1 Soil Quality Standards

Detrimental Soil Disturbance: Region 1 soil quality standards require the Forest Service to design new activities that do not create detrimental soil conditions on more than 15 percent of an activity area. In areas where less than 15 percent detrimental soil conditions exist from prior activities, the cumulative detrimental effect of the current activity following project implementation and restoration must not exceed 15 percent. In areas where more than 15 percent detrimental soil conditions exist from prior activities, the cumulative detrimental effects from project implementation and restoration should not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality.

All alternatives would comply with this standard. All of the proposed units are expected to remain below the disturbance limits of 15 percent. No units in any alternative are expected to exceed 15 percent detrimental soil disturbance.

Organic Matter: Organic matter layer thickness would be retained as appropriate for local conditions. All alternatives would comply with this standard because the currently satisfactory levels of local organic matter would be maintained within the optimum range. Harvest activities may actually increase material that would contribute to the organic surface layer through limbs and tops left on-site. Existing organic matter would not be diminished by harvest activities. It is expected that design features would maintain the organic matter at sufficient levels during harvest and fuels treatments.

Large Woody Debris: Alternative 1 would not comply with this portion of the Regional standard. Currently, sixteen of the treatment units lack sufficient coarse woody debris to meet the recommendations in Table 8. Alternatives 2 and 3 would comply with the regional standard and forest plan requirement because logging slash from tree limbs, unmerchantable pieces and tops would remain within all harvest units that are below satisfactory coarse woody debris levels. Coarse woody debris levels in those units that currently contain reduced amounts would be increased by retaining logging residue after harvest activities are completed.

National Forest Management Act (NFMA)

Timber Harvest on National Forest Lands (16 USC 1604(g)(3)(E)): A Responsible Official may authorize site-specific projects and activities to harvest timber on National Forest System lands only where:

> Soil, slope, or other watershed conditions will not be irreversibly damaged (16 USC 1604(g)(3)(E)(i)).

All alternatives comply with the NFMA. As previously discussed under the Forest Plan requirements and Northern Region soil quality standards, neither soil, slope or other watershed conditions related to the soil resource would be irreversibly damaged by implementing any of the proposed alternatives.

Summary of Effects

Alternative 1

The effects of alternative 1(no action) on the soil resource would be a mix of both positive and negative. With no action there would be no additional soil disturbance from management activities. Any previously disturbed soils would continue on a path to recovery.

Current weed populations would not receive any treatments outside of road corridors. The population that will be treated are confined mostly to travel corridors, which are not considered part of the productive land base. However, leaving the weeds untreated allows them the opportunity to rapidly invade any areas where disturbance occurs. This includes natural disturbances, like game trails and fire.

If a wildfire were to occur, the damage to soils has the potential to be severe due to localized fuel loadings. Severely burned soils are more susceptible to overland flow, erosion, mass failure and weed infestation.

Alternative 1 would not meet the Forest Land Management Plan Guideline FW-GDL-SOIL-02 or the Region 1 standard for large woody debris because of low coarse woody debris in sixteen harvest treatment units.

Alternatives 2 and 3

Requirements for the NFMA, Northern Region soil quality standards, and the Forest Land Management Plan guidelines would all be met under alternatives 2 and 3.

The primary difference between alternatives 2 and 3 as they relate to the soil resource is in the number of acres that would be prescribed burned. Alternative 2 would prescribe burn the most acres and result in the greatest amount of area treated to accomplish the purpose and need.

The chances of a soil damaging wildfire would be decreased because more fuels would be treated. Refer to the fuels report for the amount of area where risk would be reduced. This would help protect the volcanic ash layer which is critical to maintaining resiliency to drought.

Alternative 3 would accomplish proposed activities on a smaller scale and with fewer opportunities to accomplish the goals in the purpose and need for the project. Soil disturbance is expected to be less for alternative 3, due to the smaller number of acres being prescribed burned. While there would be less soil disturbance, there would be a higher possibility of incurring greater soil resource damage from fire. This would have impacts to drought resiliency and invasive weed communities.

Because design features would be followed, both alternatives are expected to accomplish the goals in the purpose and need for the project while meeting the all applicable soil quality standards and guidelines.

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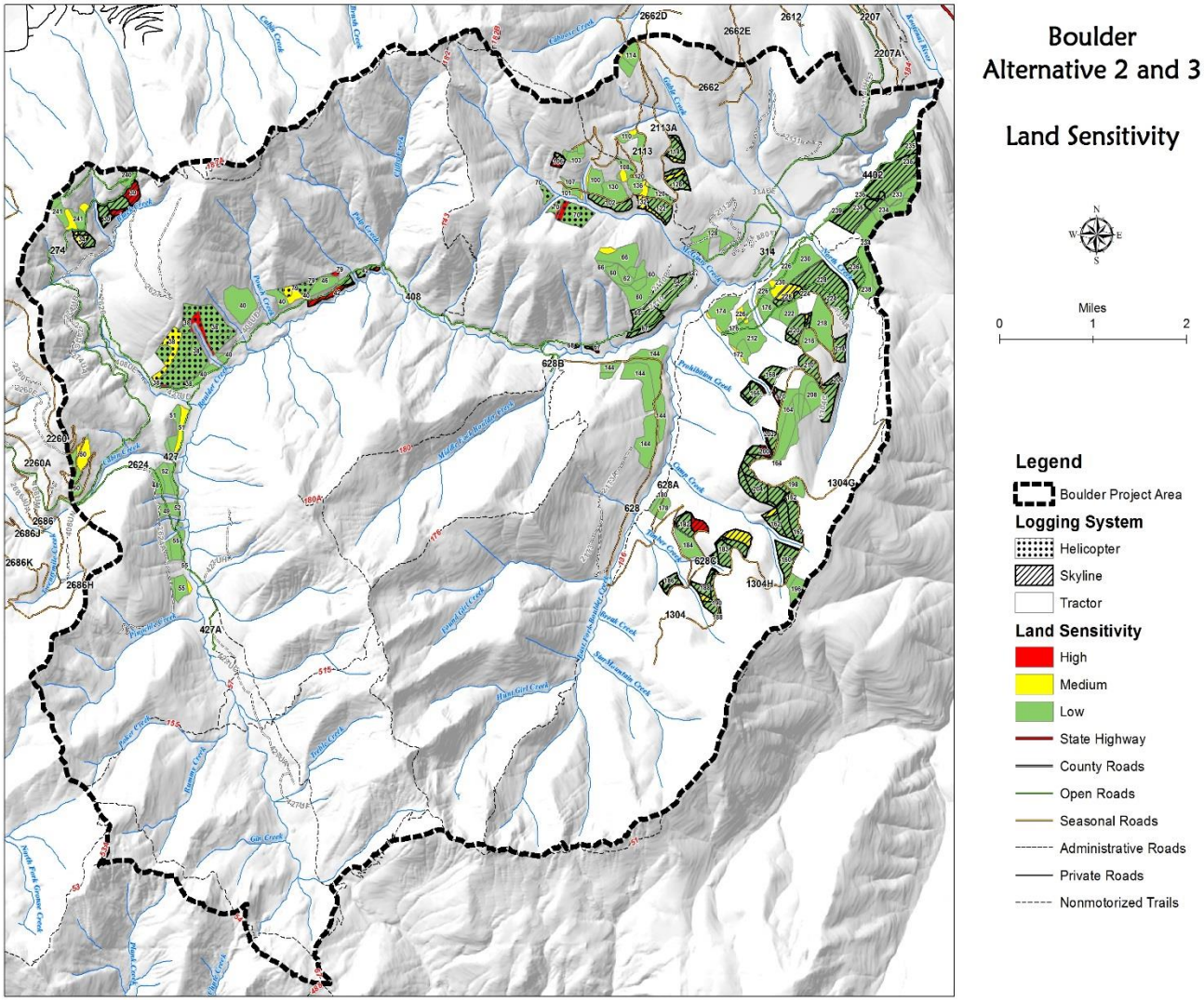
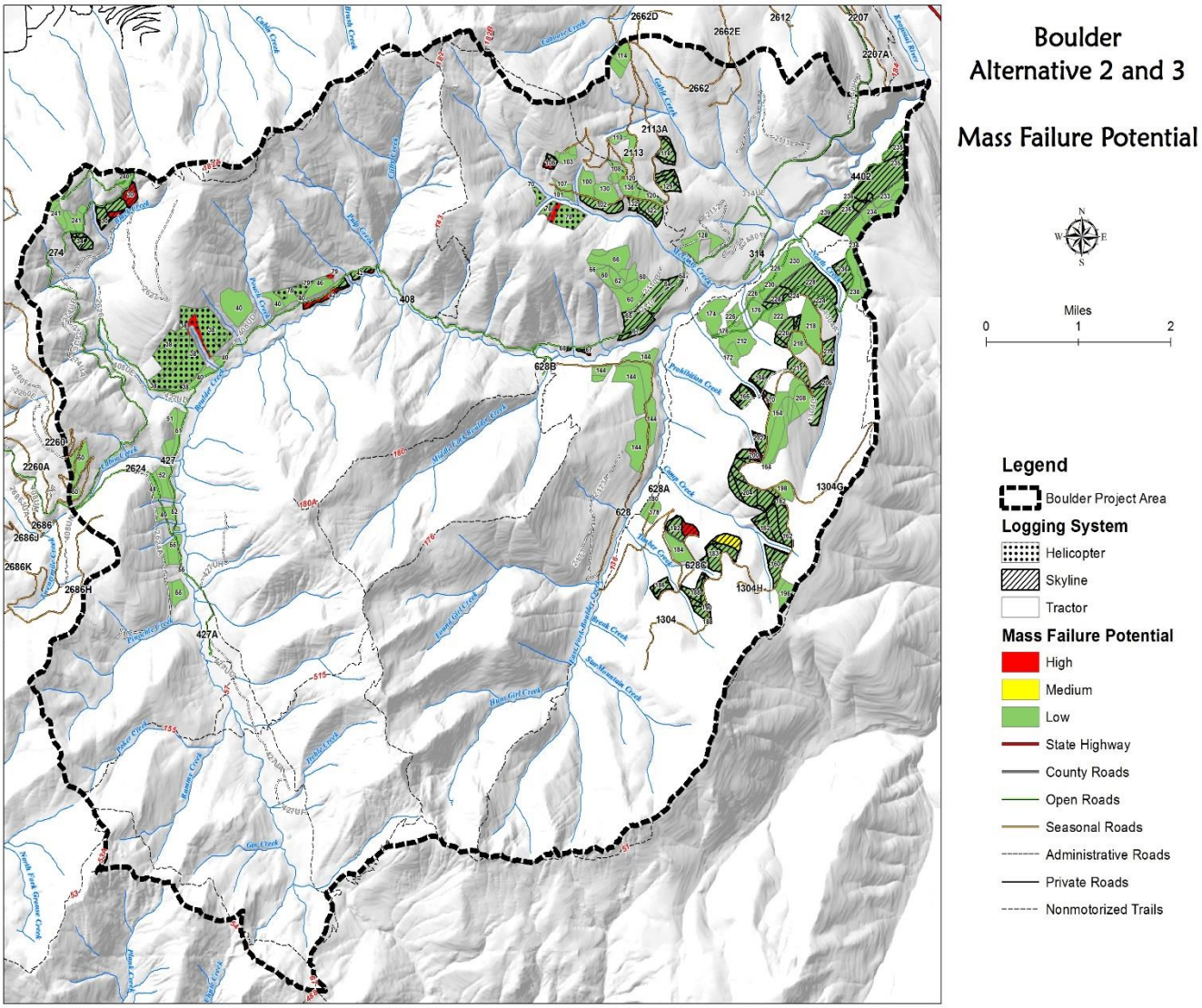
Appendix A: Maps of the Boulder Project areas for Landtype Sensitivity, mass Failure Potential, Sediment Delivery Potential, Soil Productivity, Subsurface Erosion Hazard, and Surface Erosion Hazard. See Project Record for better quality versions of maps.




Boulder
Alternative 2 and 3
Mass Failure Potential
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W
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Miles
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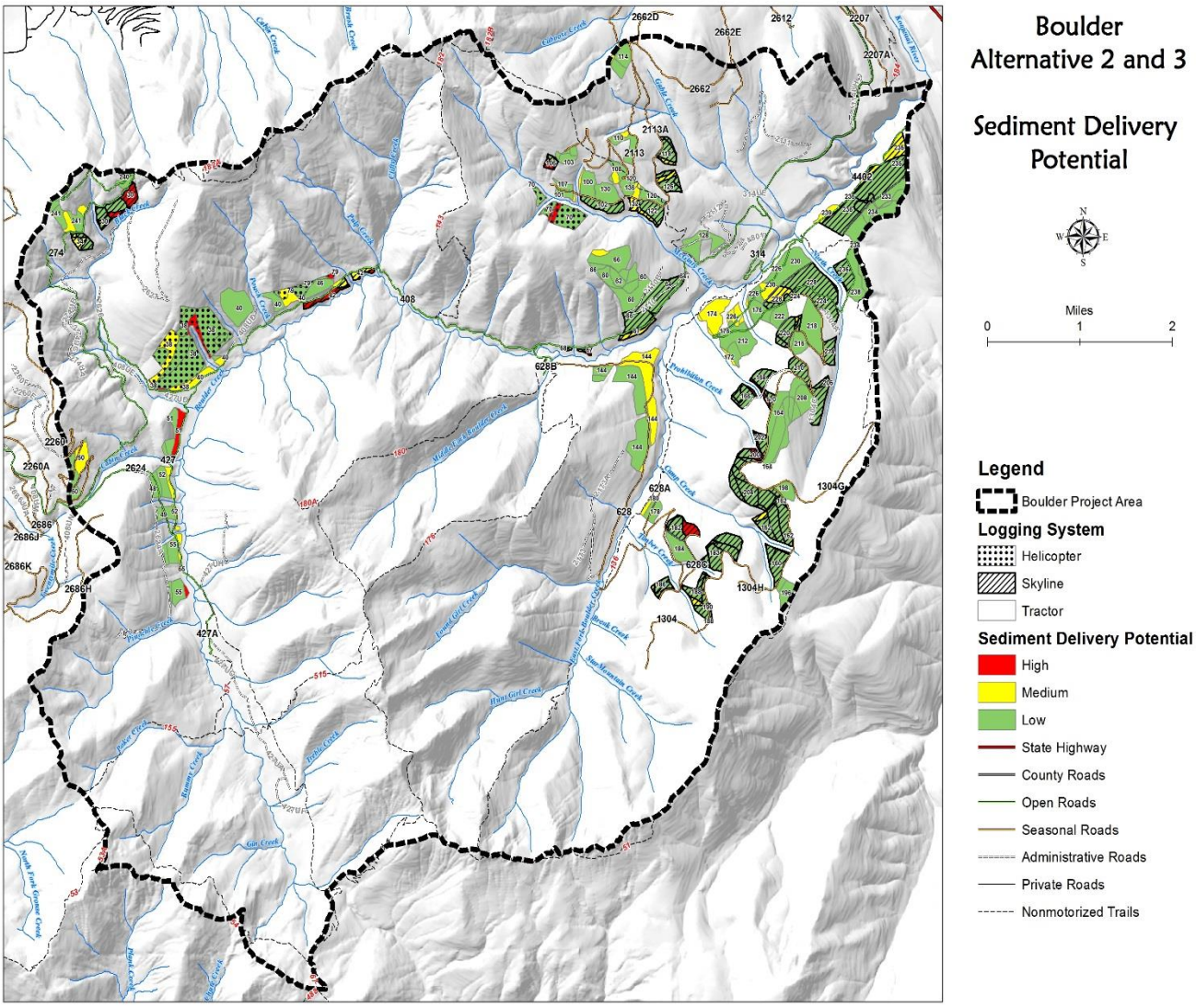
1
2
Legend
Boulder Project Area
Logging System
Helicopter
Skyline
Tractor
Mass Failure Potential
High
Medium
Low
State Highway
County Roads
Open Roads
Seasonal Roads
Administrative Roads
Private Roads
Nonmotorized Trails


Boulder
Alternative 2 and 3
Sediment Delivery
Potential
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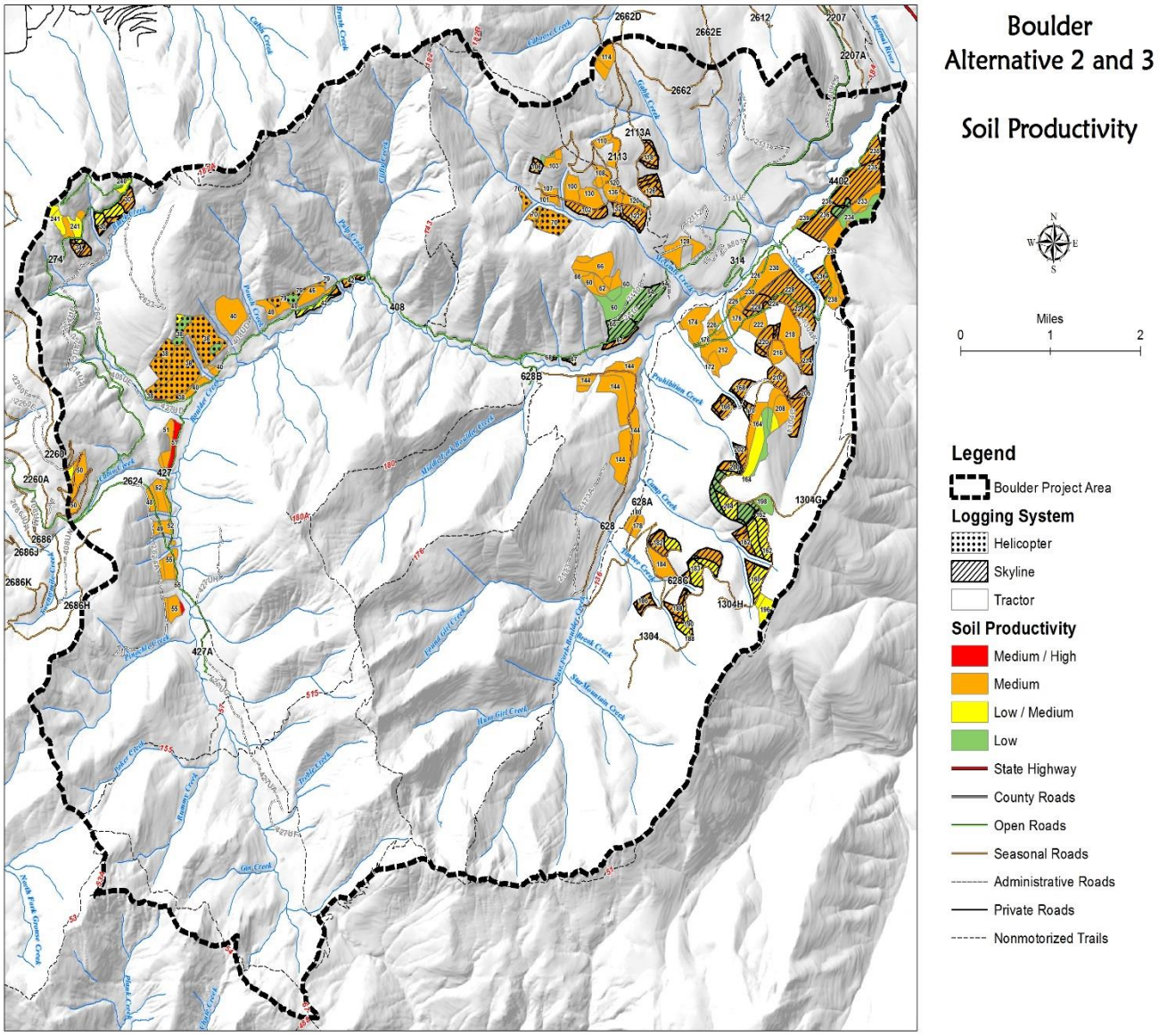
Legend
Boulder Project Area
Logging System
Helicopter
Skyline
Tractor
Sediment Delivery Potential
High
Medium
Low
State Highway
County Roads
Open Roads
Seasonal Roads
Administrative Roads
Private Roads
Nonmotorized Trails


Boulder
Alternative 2 and 3
Soil Productivity
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Legend
Boulder Project Area
Logging System
Helicopter
Skyline
Tractor
Soil Productivity
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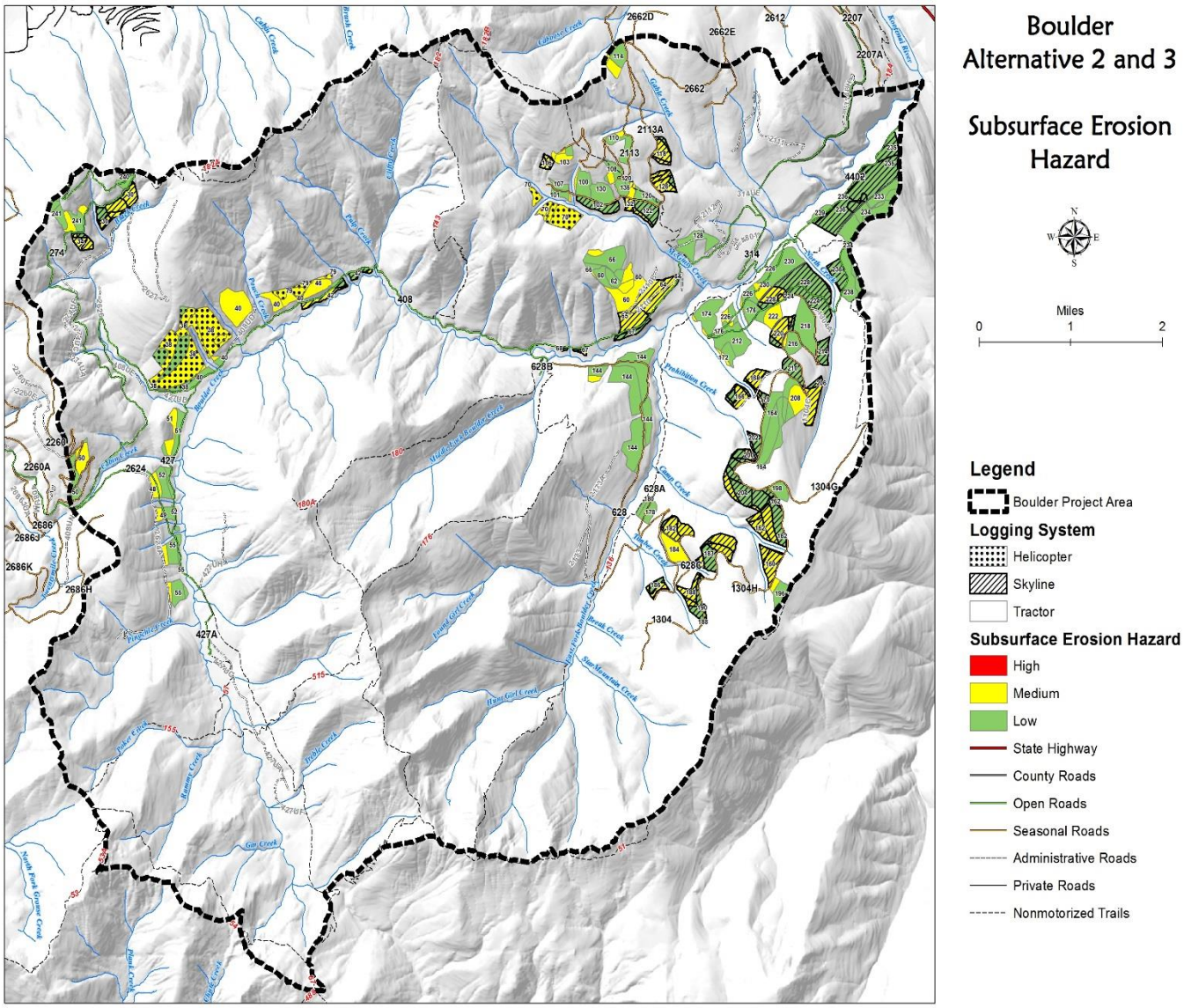
State Highway
County Roads
Open Roads
Seasonal Roads
Administrative Roads
Private Roads
Nonmotorized Trails


Boulder
Alternative 2 and 3
Subsurface Erosion
Hazard
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Miles
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Legend
Boulder Project Area
Logging System
Helicopter
Skyline
Tractor
Subsurface Erosion Hazard
High
Medium
Low
State Highway
County Roads
Open Roads
Seasonal Roads
Administrative Roads
Private Roads
Nonmotorized Trails